Whole Animal Composting of Dairy Cattle

Cooperative Extension Service
College of Agriculture and Home Economics

Guide D-108

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This publication is scheduled to be updated and reissued 5/07.

Even the most well-managed dairy operations experience animal loss due to weather, natural causes and/or illness each year. Rendering services currently pick up most carcasses from the farm. However, with the concern of Bovine Spongiform Encephalopathy (BSE), commonly known as Mad Cow Disease, feeding animal-derived protein to cattle is prohibited. This has decreased the need for animal rendering and increased the cost of removing carcasses from the farm. The abundance of stockpiled manure and old feedstuffs on dairy operations make whole animal composting a feasible alternative to carcass disposal. Objectives of this publication are to outline factors that affect proper composting procedures and discuss how to compost cow carcasses on the farm.

PROPER COMPOSTING PROCEDURES

Composting is the natural decomposition of organic materials by microorganisms that require oxygen (aerobic). Although many aspects of composting are not exact, there are several factors that affect the success of the composting process:

- carbon and nitrogen ratios (C:N ratio)
- moisture content
- particle size
- oxygen concentrations
- temperature

The proper mix of composting materials requires both carbon and nitrogen at a 25:1 to 30:1 ratio. With the proper C:N ratio, odor will be kept to a minimum, and the environment will be conducive to the growth of microorganisms. It usually is necessary to add plant materials, such as old feedstuffs or straw, to have the proper carbon levels in the manure compost mix. Sawdust is the preferred carbon source due to its highly absorbent characteristics and ability to make contact with the carcass. The compost mixture's moisture content should be 50 to 60 percent. Moisture concentrations of greater than 60 percent will generate odors and increase the chance of leachate (runoff) from the compost pile. Follow this general rule of thumb: If the mixture feels moist but no water drips from a handful when squeezed, the moisture level is adequate. To ensure aeration of the compost pile, particle size of composting materials should range between 1/8 to 1/2 inches in diameter. Proper particle size increases the pile's porosity (air space), which allows air to enter to maintain oxygen concentrations for optimal microbial growth. Aeration by turning also introduces air into the compost pile. Optimal composting temperatures range from 110 to 150°F. Compost piles need a layer of inactive material (approximately 1 foot thick) to insulate the pile and maintain high temperatures. Temperatures above 131°F for 72 hours are necessary to destroy human pathogens and most plant pathogens. Furthermore, weed seeds usually are destroyed at 145°F. Extremely high temperatures are detrimental to composting with microbial activity declining at temperatures greater than 160°F.

HOW TO COMPOST WHOLE COW CARCASSES

Contrary to popular belief and practice, simply covering carcasses in manure is not considered composting. An animal carcass generally is a mass with a low C:N ratio (high nitrogen levels with relatively low carbon), high moisture content and virtually no air. Consequently, compost materials must include high C:N ratios, moderate moisture and

Figure 1. Whole animal composting can be a successful, environmentally safe and economically feasible method to dispose of carcasses.

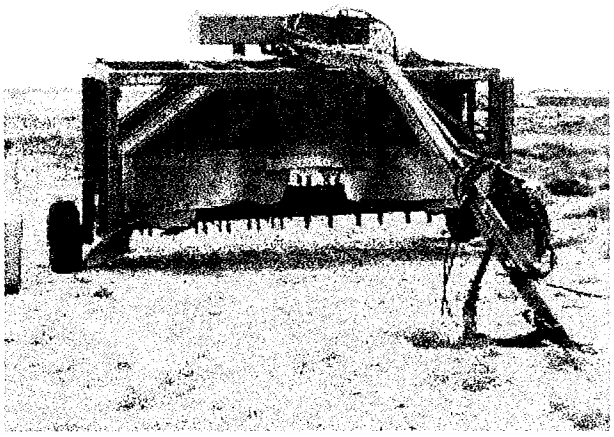

Figure 2. When temperatures fall below 145°F, the pile can be turned using a windrow turner.

satisfactory porosity for aeration. Proper composting consists of layering the carcasses with composting materials in a static pile until the soft carcass tissue has decomposed fully.

Site selection is important to the overall success of composting. The composting pile should be located to allow easy access, minimal travel, convenient handling of manure and straw/old feedstuffs, and it should be a proper distance from live cattle. Sites near neighbors and water sources or streams should be avoided. Make certain that surface runoff and other pollution controls can be implemented at the site. Good drainage of the compost pile also is necessary to prevent water from pooling. Ideal slope should be 1 to 3 percent for proper drainage. The composting pad should be firm but does not need to be paved. Sand or gravel at a depth of 6 inches is desirable when current soil conditions are not acceptable.

Compost pile construction should begin by placing on the ground a plastic liner (6 millimeter) 10 to 12 feet wide and the length of the pile or windrow (fig. 1). Next, place a base of compost materials (manure and straw/old feedstuffs) on top of the plastic liner approximately 1 to 1.5 feet deep. Manure screenings from solids separators are excellent for composting. A 50:50 ratio of manure and the carbon source generally is recommended. This ratio will vary with the chemical and biological characteristics of the manure and carbon source. Laboratory analyses of raw composting materials are necessary to get the optimal compost mixture. The carcass should then be placed on top of the base. To decrease composting time and to allow the carcass to be laid flat, the animal's body cavity should be opened; however, caution should be used due to possible disease transmission. Then water can be added. Finally, completely cover the carcass with 8 to 12 inches of the compost mixture. Apply subsequent layers as necessary until the pile or windrow is approximately 6 feet high. A thermometer should be placed 2.5 to 3 feet into the pile to monitor internal temperatures. When temperatures fall below 145°F, the pile can be turned using a front-end loader or windrow turner (fig. 2). Make certain carcasses remain fully covered after turning.

Large square hay bales can be placed around the pile's perimeter to protect from pests. Furthermore, if there is runoff from the compost pile, the hay will act as an absorbent.

In a properly managed compost pile, the core temperature of the pile should reach 145°F in 3 to 4 days. After approximately 2 weeks, volume of the pile will reduce to one-half its original size; the pile then should be turned. Decomposition of a mature dairy cow carcass generally takes 6 to 8 months with a few small bones remaining. The remaining bones will be soft and shatter easily when passed through a manure spreader during land application.

BOVINE COMPOSTING EXPERIMENT IN NEW MEXICO

Recently, 12 cow carcasses were used to initiate whole animal composting on a large (approximately 3,000 lactating cows), southern New Mexico dairy operation. Compost pile construction was established by spreading a sand/manure mixture on a level site to

Table 1. Composting mixture analyses prior to animal composting.

Nutrient	Sample #1	Sample #2	Sample #3	Average
Carbon (%)	42.8	47.8	43.8	44.8
Nitrogen (%)	4.2	3.4	.	3.8
C:N	10:1	14:1	.	12:1
Phosphorus (%)	0.01	0.01	.	0.01
Dry Matter	19.4	25.4	21.7	22.2
pH	8.5	8.4	8.0	8.3

Table 2. Composting mixture analyses after animal composting.

Nutrient	Sample #1	Sample #2	Sample #3	Average
Carbon (%)	17.9	18.1	28.9	21.6
Nitrogen (%)	2.3	1.3	2.3	2.0
C:N	8:1	14:1	13:1	11:1
Phosphorus (%)	0.01	0.01	0.04	0.02
Dry Matter	40.4	47.5	51.4	46.4
pH	8.6	8.7	8.2	8.5

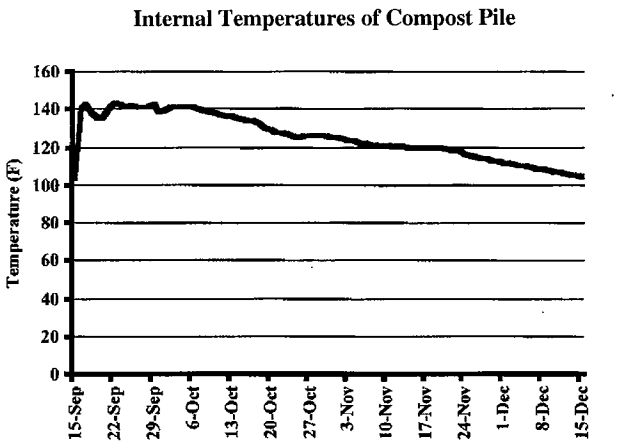

Figure 3. Compost pile temperatures reached a high of 142°F.

a depth of approximately 10 to 12 inches. A single carcass was then placed on the mixture and covered with the compost mixture to a depth of 1.5 to 2 feet. A similar technique was used to cover each carcass. Dimensions of the final pile were 14 to 15 feet wide and 6 feet high. A temperature data logger was placed 2 feet into the pile to record internal temperatures. Rainfall totaled 2 inches at the dairy during the experiment, and no additional moisture was added. Samples of composting materials were collected prior to (table 1) and after (table 2) composting cows to determine changes in nitrogen, phosphorus, carbon, dry matter and pH. Carcasses were uncovered at 2 and 4 months to determine time needed to decompose cows. Compost pile temperatures reached a high of 142°F approximately 3 days after pile establishment (fig. 3). At 2 months, carcasses were 60 to 65 percent decomposed. The bones were clean, and the flesh was 90 percent decomposed. After 4 months, carcasses were somewhat difficult to find with only several small bones (7 to 10 bones/carcass) remaining. The C:N ratio was 12:1 prior to composting and 11:1 after composting. Carbon and nitrogen percentages were reduced by approximately one-half after composting. It should be noted that the pile was not aerated nor were other carbon sources added. The goal was to mimic what would actually take place on a dairy operation. It is obvious from this study that the addition of moisture, aeration and other carbon sources would have decreased composting time but would have increased dairy producers' labor and cost.

SUMMARY

By following a few general composting recommendations, whole animal composting can be a successful, environmentally safe and economically feasible method for disposing on-farm carcasses. Cost of whole animal composting, which includes a synthetic liner, is estimated to be approximately $4 per carcass. Remember, composting procedures are not absolute and are somewhat forgiving. Trial and error accompanied with close monitoring of pile characteristics usually will produce successful results. Before implementing whole animal composting on your dairy, check local and state requirements regulating animal carcass disposal. The biological process of composting animal carcasses is similar to the processes of composting other organic materials. Carcass compost is an excellent source of fertilizer for crops used by the dairy farm. However, the compost generated from decomposed animal carcasses should not be given or sold as compost for off-farm use.

REFERENCES

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Ohio's Livestock and Poultry Mortality Composting Manual. 1999. Ohio State University Extension Publication.

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May 2002 **Las Cruces, NM**
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Disposal of Domestic or Exotic Livestock Carcasses

RG-419, PDF version
(revised 3/05)

This document is a summary of suggested guidelines from the Texas Commission on Environmental Quality (TCEQ) and the Texas Animal Health Commission (TAHC) for disposal of farm or ranch animals.

This document does not explain requirements that apply to veterinarians or commercial chicken or duck operations. For information about chicken or duck carcass disposal, see TCEQ publication RG-326, How to Dispose of Carcasses from Commercial Chicken or Duck Operations.

For rules that apply to veterinarians disposing of carcasses, refer to Title 30 Texas Administrative Code (30 TAC) Section 111.209(3).

By planning in advance how you will dispose of carcasses, your facility will be better prepared to deal with environmental and health issues. Emergency cases may be handled differently. Contact your regional TCEQ office in the event of an emergency.

Why is disposal of carcasses regulated?

On-farm disposal of dead animals should always be done in a manner that protects public health and safety, does not create a nuisance, prevents the spread of disease, and prevents adverse effects on water quality.

Who is responsible for making sure the carcasses are properly disposed of?

The owner or operator of the farm or facility is responsible for disposal in a timely and sanitary manner. Please be aware that under 30 TAC Section 335.4 this means there can be no discharge into or adjacent to waters in the state. There can be no creation or maintenance of a nuisance and there can be no endangerment of public health and welfare.

How soon must they be disposed of?

TAHC rules require that animals that die from a disease recognized as communicable by the veterinary profession must be disposed of within 24 hours by burial or burning. Animals dying from anthrax or ornithosis must be killed, then burned on-site within 24 hours.

How can I dispose of the carcasses?

There are several options including on-site burial, composting, or sending the carcass to a municipal solid waste landfill, renderer, or commercial waste incinerator. TCEQ rules allow animals to be burned when burning is the most effective means to control the spread of a communicable disease. The animal must be burned until the carcass is thoroughly consumed. The cover requirements described in 30 TAC Chapter 330, Section 136(b)(2) should be adequate for burial of farm and ranch animals in most cases. Some diseases are reportable, and you are required to contact the TAHC at 1-800-550-8242 prior to disposing of animals with these diseases. TAHC can also provide a list of reportable animal diseases.

Where can I bury?

If you decide to bury the animal, the burial site should not be located in an area with a high water table or with very permeable soils. The TCEQ suggests that animals be buried far enough from standing, flowing, or ground water to prevent contamination of these waters, and in an area not likely to be disturbed in the near future.

Suggested Setbacks for Burial

- Drinking water wells - At least 300 feet from the nearest drinking water well.
- Surface water - At least 300 feet from the nearest creek, stream, pond, lake, or river, and not in a floodplain.
- Neighbors - At least 200 feet from adjacent property lines.

Where can I burn?

When burning, do not do so in an area where a nuisance or traffic hazard would be created.

Suggested TCEQ Setbacks for Burning

- Adjacent properties - Downwind of, or at least 300 feet (90 meters) from, occupied structures.
- Weather conditions - If possible, burn during the day when the wind speed is > 6 mph or < 23 mph. Monitor the fire, and complete the burn the same day.

Notification Requirements

Notify the TCEQ by letter if you expect to bury animal carcasses on your farm. Your letter should contain your full

name and address, the type of animals, and a short description of the locations on your farm where the carcasses will be buried. Information on the anticipated capacity of the burial areas as well as the use of daily and/or final cover should be included, and a map showing the general location of the area would be useful. This letter will be considered as your compliance with 30 TAC Section 335.6 and will be acknowledged by the TCEQ. Mail your notification to the address listed under the "Additional Information" section of this document.

Once you notify us, do not send additional letters. However, if you have more than 10 animals die at one time, it is recommended that you contact the TCEQ regional office near you since multiple mortalities are handled on a case-by-case basis. If the location of burial changes, or if additional burial areas are used, then an updated Section 335.6 notification should be provided.

Disclaimer

This document is intended as guidance to identify the requirements for the disposal of animal carcasses; it does not supersede or replace any state or federal law, regulation, or rule. It is the responsibility of the owner to be knowledgeable and to remain abreast of guideline or regulation developments. Please refer to the "Additional Information" and "Recommended References" sections for more specific information.

Additional Information

Rules regarding carcass disposal: Rules that are directly related to carcass disposal are in 30 TAC Chapters 335 and 111 including Sections 335.4 – 335.6, which deal with general waste disposal requirements, and 111.209(2) "Exception for Disposal Fires"

Rules for poultry disposal: 30 TAC Chapter 335—including Section 335.6, "Notification Requirements," and especially Section 335.25, "Handling, Storing, Processing, Transporting, and Disposing of Poultry Carcasses"

Disposal rules that apply to veterinarians: 30 TAC Section 111.209(3)

Water quality rules for concentrated animal feeding operations (CAFOs): 30 TAC Chapter 321, Subchapter B; For composting operations: 30 TAC Chapter 332; For municipal solid waste (landfills): 30 TAC Chapter 330

Nuisance Rules, General Rules: 30 TAC Chapter 101 Section 4 and CAFO Rules: 30 TAC Subchapter B Section 321.31

Public Health Rules: Sections 81.081-81.086 of the Texas Health and Safety Code

Texas Animal Health Commission: Texas Agriculture Code Chapters, 161 to 168. Contact: 1-800-550-8242 prior to disposing of diseased animals. TAHC also can provide a list of reportable animal diseases.

Notification for onsite burial of carcasses: Industrial and Hazardous Waste Permits Section, MC-130, TCEQ, P.O. Box 13087, Austin, Texas 78711-3087 ; Phone: 512/239-6595 Fax: 512/239-6383. It is recommended you contact your TCEQ Regional Office if you have more than 10 animals die at one time and you plan to dispose of them on-site.

TCEQ Rules: Rules and publications are available at www.tceq.state.tx.us or 512/239-0028

TAHC Rules: Rules and publications are available at www.tahc.state.tx.us

Recommended References

How to Dispose of Carcasses from Commercial Chicken or Duck Operations (TCEQ RG-326; April 2000) explains carcass disposal rules and options for anyone who hatches, raises, or keeps chickens or ducks for profit.

Catastrophic Animal Mortality Management (Burial Method), Technical Guidance, USDA/Natural Resources Conservation Service, Texas State Soil and Water Conservation Board, February 11, 2002

NRCS TX Conservation Practice Standards: Code 316 - Animal Mortality Management

OSHA Construction rules: www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1926.html

OSHA Excavation Rules: www.osha-slc.gov/OshStd_toc/OSHA_Std_toc_1926_SUBPART_P.html

Title 2, Texas Water Code, Chapter 26, Subchapter H, Poultry Operations: www.capitol.state.tx.us/statutes/statutes.html

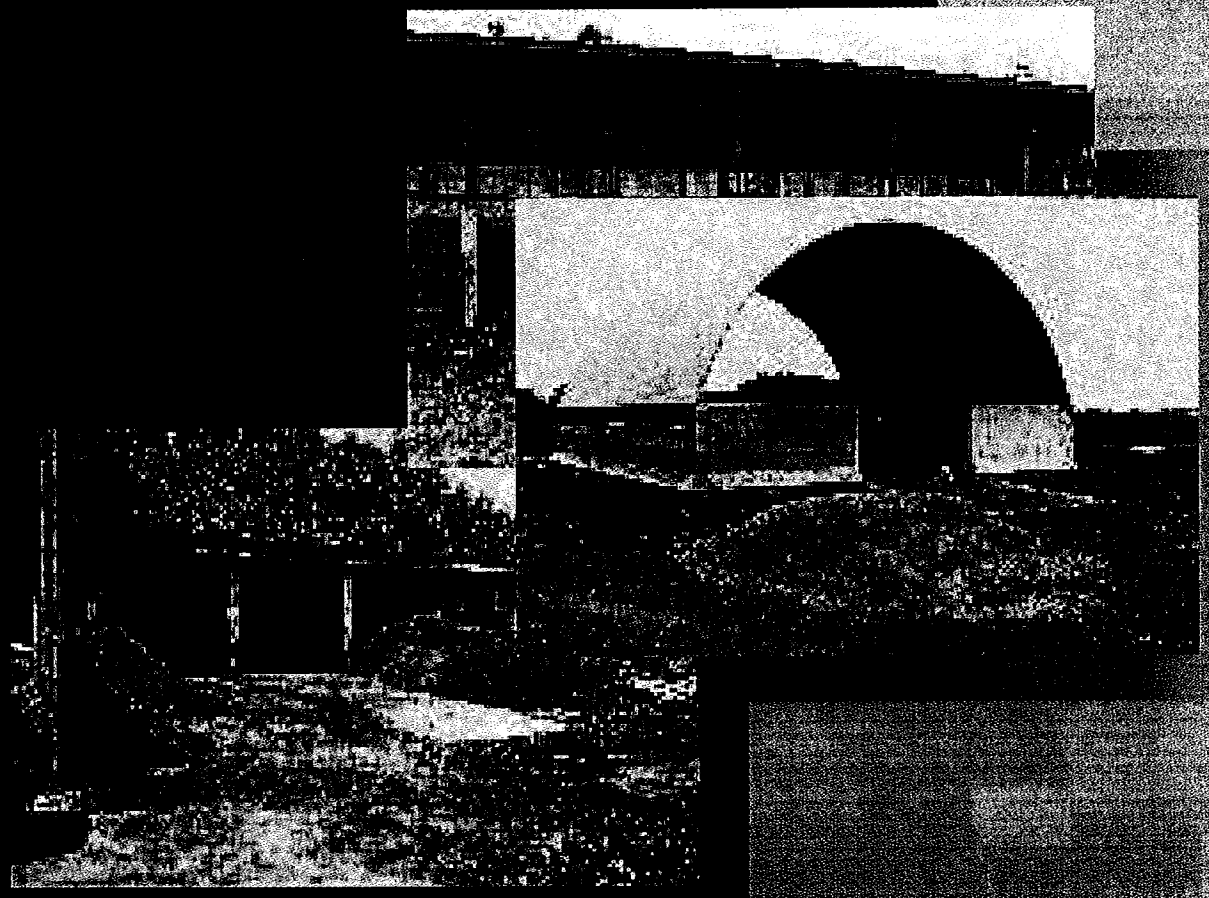
Senate Bill 1339, and House Bill 3355 (77th Legislature, 2001): www.lrl.state.tx.us/isaf/lrlhome.cfm

Texas Occupations Code, §801.361, Disposal of Animal Remains (78th Legislature, 2003): www.capitol.state.tx.us/statutes/oc.toc.htm

CALL BEFORE YOU DIG

Call 1-800-344-8377 to make sure you will not accidentally hit a gas or utility line on your property when digging a hole to bury animal carcasses.

Composting Animal Mortalities



Minnesota Department of Agriculture
Agricultural Development Division

in cooperation with
Minnesota Board of Animal Health
University of Minnesota Extension Service

Composting Animal Mortalities

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Updated July 2006

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This report is also available on the Minnesota Department of Agriculture web site: www.mda.state.mn.us

NOTES

The management of animal mortalities is an important aspect of livestock farming since even the best livestock farmers lose some of their animals each year. Rendering, burial, and incineration have been the typical carcass disposal methods. However, these options are becoming less practical for many farmers because of decreasing availability and higher costs of rendering, biosecurity concerns, and potential adverse effects on groundwater and air quality. For these reasons, composting is becoming more widely used as a method of mortality disposal. A properly managed mortality composting system is low cost, environmentally sound, biosecure, and virtually odor free.

While there is much in favor of composting, you must decide whether or not it fits into your operation. Minnesota Board of Animal Health regulations allow composting of poultry, swine, sheep, and goats without a permit, and cattle can legally be composted if a permit is obtained. Like any other farm operation, successful composting requires a commitment to managing it well.

This publication describes mortality composting, answers commonly asked questions, outlines what is needed to compost on your farm, explains how to compost step-by-step, and outlines applicable regulations. It also contains resources for more information.

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CONTENTS

INTRODUCTION

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THE MORTALITY COMPOSTING PROCESS

Composting is an aerobic, natural process in which microorganisms convert organic material into a stable product called compost.

Composting is a naturally occurring process in which bacteria, fungi, and other microorganisms convert organic material into a stabilized product termed compost. This means that microorganisms do the composting work for you. Your role in managing the composting process is to make sure that the microorganisms have the environment they need in order to do their work quickly and effectively.

In mortality composting, the animal carcass is placed in a composting bin. A bulking agent such as sawdust or straw that is high in carbon is placed around the carcass to completely surround it.

Within the carcass, anaerobic microorganisms work to degrade it, releasing fluids and odorous gases such as hydrogen sulfide and ammonia. These diffuse into the surrounding bulking agent. In this bulking agent, aerobic microorganisms degrade these materials to odor-free carbon dioxide (CO_2) and water (H_2O). The aerobic process produces considerable heat, causing the temperature of the compost pile to rise. The active bacteria in both the aerobic and anaerobic zones are heat tolerant. However, the heat kills common viruses and bacteria that may be present in the carcass. Odor is controlled by having an adequate quantity of bulking agent around the carcass.

Composting produces
- ***Carbon dioxide***
- ***Water***
- ***Heat***
- ***Fertilizer***

The compost pile is usually left undisturbed until the temperature has subsided, meaning that the aerobic microorganisms are working less efficiently because they have exhausted much of the food and air in their environment. At this point the flesh and small bones will have decomposed. After this first heat cycle, the pile is turned, introducing air into the pile. This increases aerobic activity and the temperature rises again. After the temperature subsides a second time, the compost should be finished, with no flesh, hide, or small bones present, although some large bones may remain.

How the Mortality Composting Process Works on the Farm

On the farm, at least three composting bins are used:
1. A primary bin in the process of being filled
2. Another primary bin in the first heat cycle of composting, and
3. A secondary bin in the second heat cycle

When you first start composting, new carcasses and bulking agent are added to the first bin until the bin is full. This pile is then left to compost and new carcasses are layered with bulking agent into a second bin. When the first pile has completed the first heat cycle, the pile is turned by moving it to a third empty bin, and it is left to compost for the second heat cycle. By this time, the second bin is usually full and is left to compost. A new pile is started in the first bin, which is now empty. When the first pile has gone through the second heat cycle, it is removed from the bin and either stored or spread on crop fields. This on-going process ensures that carcasses can be disposed of continuously.

It takes from 7 to 24 weeks for carcasses to degrade and for the compost to reach the finished stage. The amount of time required depends on the bulking agent used, temperature, moisture, management, and the size of the animal (large animals can take longer to decompose than small animals).

The Animal Mortality Composting Process

First Heat Cycle

- Carcasses and bulking agent layered in pile
- High rate of anaerobic and aerobic activity
- Temperature increases
- Breakdown of flesh and small bones
- Temperature subsides

Second Heat Cycle

- Turning the pile initiates increased aerobic activity
- Temperature increases
- Breakdown of long bones, skull and pelvis
- Stabilization of compost material
- Temperature subsides

Changes in Materials During Composting

Finished compost is
- ***Consistent and soil-like***
- ***Dark brown to black***
- ***Reduced in volume and weight***

By the time composting is complete, the material becomes more uniform and less active biologically. The material (humus) becomes dark brown to black in color. The particles reduce in size and become consistent and soil-like in texture. The volume and weight of materials are reduced due to loss of carbon dioxide and water to the atmosphere and to bulky raw materials changing into crumbly, fine-textured compost.

Why Composting is a Good Choice

Composting is
- ***Biosecure***
- ***Environmentally sound***
- ***Cost effective***
- ***Easy***

Biosecure
Composting allows immediate year-round disposal of carcasses so that disease is not spread. There is no entry of off-farm vehicles that can bring disease onto the farm from other operations, and the high temperatures in the compost pile kill pathogens.

Environmentally sound
A properly functioning compost pile gives off little odor and does not harm or affect groundwater. Composting turns a waste into a beneficial fertilizer and soil amendment, resulting in on-farm nutrient recycling.

Cost effective
Composting has low to moderate start up costs and minimal operating costs.

Easy to accomplish
Composting requires only good management and minimal training.

COMMONLY ASKED QUESTIONS About Composting

Will I have problems with odor?

No. A properly managed compost pile with enough bulking agent will not produce offensive odors. Farmer cooperators in three Minnesota demonstration projects found that the layer of sawdust or bedding on top of the pile greatly reduced odor and, once the compost heated up, offensive odors were essentially absent.

Will the composting piles attract flies and rodents?

No. Flies are not a problem because internal temperatures above 130° F will kill existing fly larvae. Also, when piles are covered by at least 12 inches of bulking agent, flies and rodents are not attracted to the area. If manure is used in the pile and not covered adequately by a bulking agent, some flies may be present on the surface but they will not be able to reproduce.

Will the compost spread diseases?

No. The high temperatures of proper composting will destroy most harmful bacteria and viruses associated with livestock. Viruses that cause avian influenza, Newcastle disease and pseudorabies are completely inactivated by the end of the second heat cycle. Bacteria such as *Salmonella enteritidis, Pasteurella multocida, Erysipelas rhusiopathiae* and *Salmonella cholerasuis* will be successfully destroyed by the composting process.

Will composting work with all animals?

Yes. Poultry, swine, sheep, and goats can all be composted without a permit. The Minnesota Board of Animal Health regulations require a permit for cattle. With larger animals such as sows and larger cattle, some of their large bones may take longer to decompose than with smaller animals. These bones can be removed from the finished compost and returned to an active pile for further composting. Note that while any species can be composted, Minnesota Board of Animal Health regulations do not allow composting of any animals that died from anthrax or toxic materials.

Will I recognize animal parts in the compost when I turn it?

No. Farmer cooperators in three Minnesota demonstration projects found that when the piles were ready for the first turning, the only recognizable parts were larger bones, teeth, and pieces of hides. These bones were rubbery and decalcified, and could be broken easily. There were even fewer after the second turning.

Is composting costly?

No. The main cost is in building a composting structure. Some farmers in Minnesota have renovated existing buildings for little cost. Another cost may be a front-end or skid steer loader to handle the mortalities and compost. The only on-going cost is the bulking agent and the skid steer. Your farm may have bulking agents (such as straw, litter, bedding, or corn stalks) available at no cost. If not, you will have to purchase bulking agent. This cost should be minimal.

Will composting take a lot of labor?

No. The labor involved is minimal, consisting of placing any new mortalities in the bin every day and covering them with bulking agent, checking the temperature of the pile every day, moving the pile between the primary and secondary stages of composting, and moving the finished compost to storage. One Minnesota farmer who had a composting demonstration site on his farm estimated that it took about ten minutes each day to manage.

Are there uses for the compost when it's done?

Yes. The finished compost can be used in your next compost pile to replace part of the bulking agent and provide a large microbial population right away. It can also be spread on crop fields to provide beneficial organic matter and nutrients to the soil and the crops.

Can composting be done in the winter in Minnesota?

Yes. Active piles will continue to heat during the winter. New piles should not be started during the winter unless active, hot compost is available as the bulking agent.

Can any size operation use composting?

Yes. However, if small operations use a seasonal livestock production cycle, they may have trouble composting in winter if the input of carcasses is small and inconsistent. Small compost piles do not heat as fast or as hot and are not self-insulated, and therefore may not reach ideal temperatures in winter.

Can varmits be a problem around the compost pile?

Yes. Visiting dogs, coyotes, raccoon, skunk and fox can become problems. A very hot and active compost pile where the carcasses are adequately covered is the best solution.

THE MECHANICS of Composting

Your job in managing the compost pile is to provide the right food and environment for the microorganisms so that they can get their composting work done quickly and effectively. There are four aspects of the compost pile that are important to microorganisms and that are important in your management of the process.

Compost microorganisms need
- ***Carbon***
- ***Air***
- ***Water***
- ***Elevated temperature***

1. Carbon: Because animal carcasses are very high in nitrogen, you must add large amounts of carbon (in the form of a bulking agent) to the pile in order to provide the right environment and food for the composting microorganisms. The carbon to nitrogen ratio (C:N ratio) describes the amount of carbon compared to the amount of nitrogen in the pile. Minnesota Board of Animal Health regulations require that the C:N ratio of the pile be between 15:1 and 35:1. However, you don't need to be too worried about measuring the exact C:N ratio, since the composting process is fairly forgiving and will occur under a range of C:N ratios, as long as you keep the overall carbon to nitrogen balance in mind. If there is too little carbon (low C:N), the high nitrogen supply is converted to ammonia and is emitted from the pile, resulting in odors. If there is too much carbon (high C:N), the low nitrogen supply can limit microbial activity resulting in slow carcass decomposition and cool temperatures.

2. Air Flow: Since aerobic microorganisms need oxygen to work, oxygen must be able to move into the pile and carbon dioxide and water vapor must be able to escape. This means that the bulking agent must have a particle size that allows air to move freely. Bulking agents, such as newsprint, can pack down, inhibiting air flow to the microorganisms, which will slow or even stop the composting process and produce odors. Large particles, such as branches, can let too much air in, cooling the pile and slowing down the work of the microorganisms.

3. Moisture Content: Microorganisms require water as a medium for chemical reactions, to transport nutrients, and to move about. Compost with too little moisture will not supply sufficient water for microorganisms to survive. Too much moisture inhibits oxygen flow through the pile, causing aerobic microorganisms to slow down, which can lead to odors.

4. Temperature: Temperature is both a necessity for and a result of microorganisms' work. The warmer the pile, the faster the micro-organisms work, the more heat they produce, the warmer the pile, and so on. If the temperature is too low (less than 120°F), microorganisms are not very active, which means decomposition will occur at a slow rate and pathogens and weed seeds will not be

destroyed. The temperature should reach 130° to 150° F for several days or weeks because at this temperature, microorganisms are active, decomposition proceeds quickly, and pathogens are destroyed.

WHAT YOU NEED TO GET STARTED

Bulking Agent

Bulking agent considerations
- ***Availability***
- ***Cost***
- ***Particle surface area***
- ***Carbon to nitrogen ratio***

Many organic materials can be used as bulking agents, but different materials vary in their availability, cost, and physical characteristics. Sawdust has been widely used and has excellent odor-absorbing potential. Hay and straw will also work. Greener hay or hay with more legumes will have less carbon (lower C:N ratio) while drier hay or hay with more grass will have more carbon (higher C:N ratio). Crop residues such as wheat straw or corn stalks can be used but may require shredding or some form of particle size reduction.

You can also use finished compost as part of the bulking agent in a new pile. This has the advantage of inoculating the new pile with microorganisms. Some typical bulking agents and their characteristics are shown here.

When choosing a bulking agent, you should also consider:

1. Availability: You must have access all year to enough bulking agent to make sure your piles compost well. Check out both on-farm and off-farm sources and make sure the bulking agent you decide to use will be available consistently and in high enough quantities from one or more sources throughout the year.

2. Cost: While the cost of on-farm materials is low, it is possible to find bulking agents from other sources that may also be low cost. This is especially true for materials that are considered waste products such as sawdust or wood shavings.

Common Composting Materials

Substance	*Carbon to Nitrogen Ratio (Weight to Weight)*
Sawdust[1]	200 - 750 :1
Straw[1]	48 - 150 :1
Corn stalks[1]	60 - 73 :1
Finished compost[1]	30 - 50 :1
Horse manure[1]	22 - 50 :1
Turkey litter[1]	16 :1
Animal carcass[2]	5 :1
Swine manure[2]	1 - 3 :1

[1] On-Farm Composting Handbook, NRAES-54, Natural Resource, Agriculture, and Engineering Service, Ithaca, New York.

[2] Compost Materials, 1996, EBAE172-93, North Carolina Cooperative Extension Service, Raleigh, North Carolina

3. Physical Characteristics: The physical characteristics of the bulking agent will affect how well your compost piles work. In addition to choosing a bulking agent with the appropriate C:N ratio, you want to find a bulking agent with a large enough particle size to let air flow, but not to the point that it cools the pile. It should have enough surface area for the microorganisms to grab onto.

Whatever bulking agent you decide to use, you can calculate the annual volume needed based on your annual death loss. Using sawdust as an example to estimate the bulking agent volume you will need for one year of composting, first determine the pounds of death loss you have per year (use tables on pages 16 and 17), and then multiply by .0067 yd^3 per pound of dead animal. This will give you an estimate for planning purposes only. Other bulking agents may differ. If you will use finished compost to replace part of your bulking agent, remember to factor that into your estimates.

Water

Composting happens most ideally when the pile is moist. This means that you may have to add water to your compost pile. The amount of water you will add will depend on the moisture content of your compost ingredients, especially of your bulking agent. In general, you can judge the proper moisture content by feeling the compost. It should be moist and leave your hand feeling moist, but you should not be able to squeeze any water out of it.

Other Ingredients

Manure can also be used in the compost pile but is not necessary. Manure tends to be high in nitrogen and low in carbon . The advantages of using manure are that it adds microorganisms to the pile, adds nitrogen which can help speed up the composting process, and adds moisture. The disadvantage is the danger of excessive nitrogen in the pile resulting in odor, flies and other composting problems. You may have to add more bulking agent to compensate for the increased nitrogen.

Liquid manure has very little carbon (low C:N ratio), while manures cleaned from stalls may include bedding material which will increase the carbon (higher C:N ratio). Turkey litter has been used in some composting piles in Minnesota.

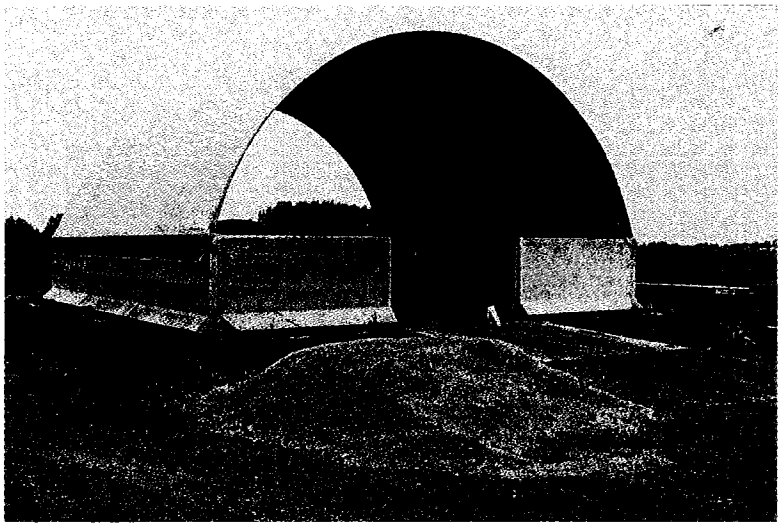
Other Supplies

Thermometer: A probe-type thermometer with a minimum 36-inch stainless steel stem is needed to monitor the pile. Suppliers of thermometers are included in Further Resources.

Composting Log: A logbook is needed where you can record dates and weights of carcasses placed in the composter, temperature readings, amounts of bulking agent used, dates when compost is turned, and dates and amounts of finished compost.

Front-End or Skid Steer Loader: The loader is needed to move carcasses from the production buildings to the composter, place carcasses in the compost pile, cover the carcasses with bulking agent, mix and turn compost, and move finished compost.

Manure Spreader: A manure spreader should be available for field spreading finished compost.



Hoop structure with six bins; note concrete apron and sawdust pile in foreground.

COMPOSTING STRUCTURES

A wide range of structures is possible, including new or existing facilities, and stand-alone units or add-ons to an existing building. For new facilities, poured concrete, pole construction, and hoop houses have all been used in Minnesota. Existing facilities, such as machine sheds, corn cribs, or cattle sheds can be adapted if the ceiling is high enough to allow the front-end or skid loader to lift and turn the compost. This can be a low cost option. One Minnesota farmer adapted a Cargill open-front unit for composting with no remodeling costs.

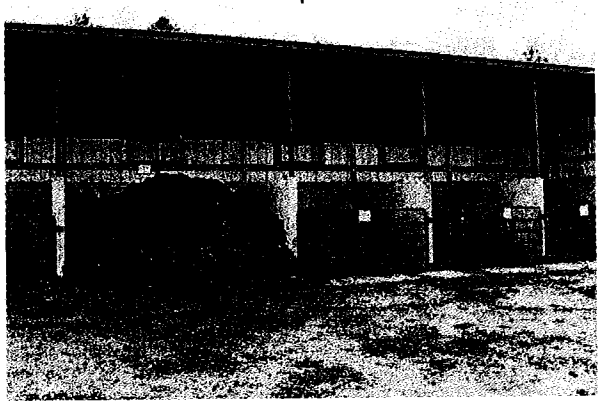
Composting structure regulations
- ***Impervious weight bearing pad***
- ***Covered***
- ***Rot resistant building materials***

Minnesota State Board of Animal Health regulations recommend that the structure be:

- **built on an impervious weight-bearing pad that is large enough to allow the equipment to maneuver.** A concrete pad or other surface prevents seepage of nutrients and bacteria to groundwater. An 8-foot apron to at least support the front wheels of the loader is the minimum recommended; concrete to support the entire tractor is recommended.

- **covered with a roof or other water-repelling materials to prevent excessive moisture on the composting material.** A roof excludes rainwater and snow from the compost piles. The roof overhang should minimize rain blowing into the bins.

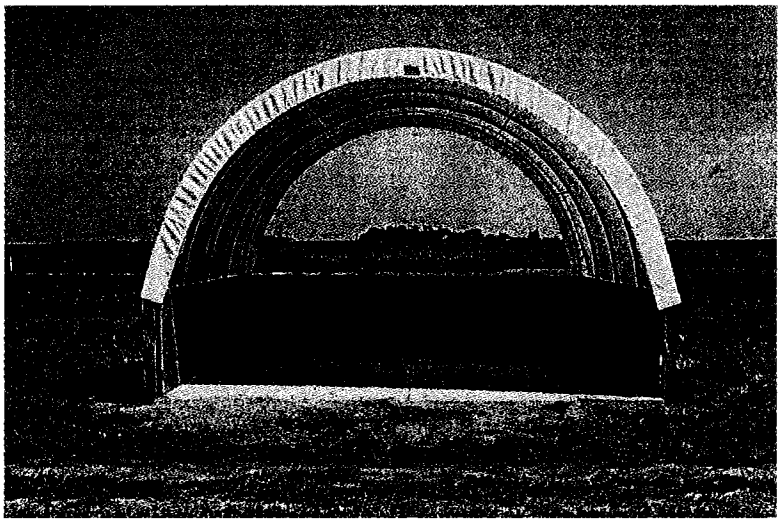
- **built of rot resistant material that is strong enough to withstand the force exerted by the equipment.** Possible construction materials for the bins include preservative pressure-treated lumber and concrete. To avoid corrosion, ventilation is needed and hot-dipped galvanized nails should be used.



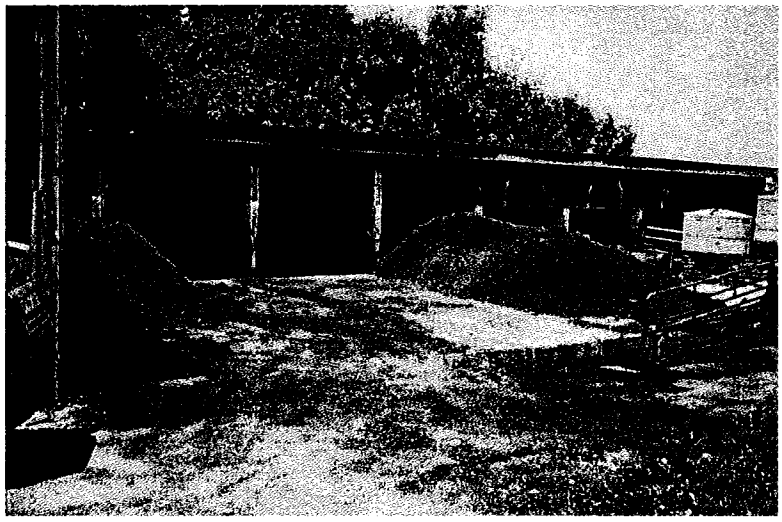
Multiple bin composting structure; note gates on fronts of bins.

Bins should be located close to each other to facilitate moving compost from bin to bin. Consider snow and wind loads in the design. If you find you have problems with dogs or other animals that dig in the piles, you might want to add a removable gate. Opposite are some photos of typical composting structures used in Minnesota.

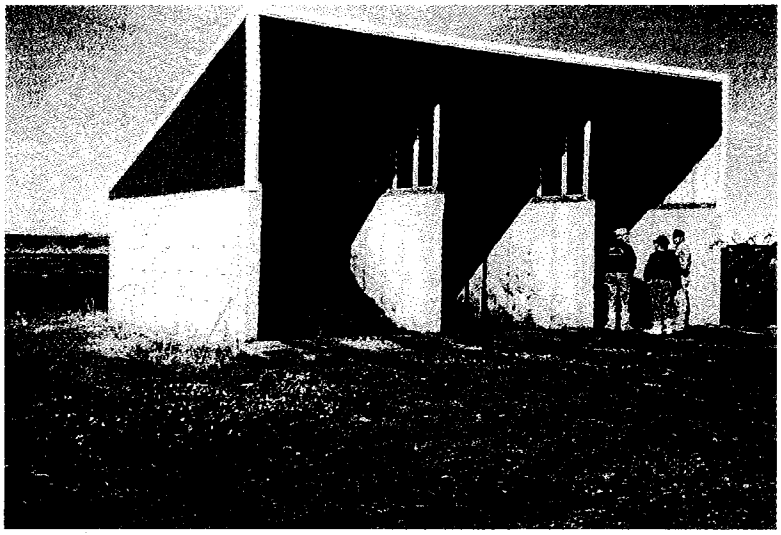
Hoop structure for composting with three bins.



A Cargill unit converted for composting.



New three bin composting structure.



Size of the Composting Structure

The size of your composting structure will depend on the size and amount of dead animals to be composted on a daily basis. The adjacent table lists average death losses for different animals. The primary bin volume averages three to 20 cubic feet for every pound of death loss. The table on the next page gives the ratio by size of animal. Secondary bins (those used to turn piles into for the second heat cycle) should be the same number and volume as the primary bins. The three steps described on the next page in the text box will help you calculate the size and number of your composting bins.

Mortality Estimates

Species	*Average Weight (lbs)*	*Loss (%)*
Swine[1]		
wean to nursery	10	
10-12		
nursery	30	2-4
grow finish	150	2-4
sows	300	2-5
Poultry[2]		
broiler	3	5
layer	3	10
turkey hens	10	7
turkey toms	17	13
Beef[3]		
pre-wean	90	8-10
young stock	600	2-3
yearlings	850	1
cows	1250	1
Dairy[4]		
pre-wean	90	8-10
heifers	600	2-3
cows	1400	1
Goats and Sheep		
pre-wean	8	8-10
lambs	50	
10-12		
mature	170	6-8

Composting structures that are too small may force movement of material through the bins before the composting process is complete. This can increase management problems.

Bin Size

Your goal in determining the bin size is to maximize the efficiency of the composting process and make it easy to manage the mortalities and the composting materials. All bins should be equally sized. Bin size depends on the size of equipment you will be using to turn the compost and the type of animal you will be composting. Bin width should be at least twice the width of the bucket on the equipment you will be using. The size of the structure you might be renovating must also be considered when determining bin size. Experts recommend that the bin area (width x length) should be 100 to 400 square feet to ensure proper heating and for ease of filling and emptying over a short period of time.

Number of Bins

The number of bins will depend on the bin size and your total composting volume of carcasses and bulking agent. The minimum number of bins is three, two for composting and one being filled. Larger operations may require more than three. Your goal in determining the number of bins is to be able to successfully compost all of your animal mortalities. Minnesota State Board of Animal Health regulations require that the composting structure be large enough to handle each day's normal mortality through a minimum of two heat cycles to the endpoint of the composting. You will also need to consider where you will store the bulking agent and finished compost. Having extra bins available for this can be helpful.

Designing the Compost Structure

Step One: Estimate the Weight of Average Daily Death Loss.
You can use your own farm records or estimate the loss using industry average loss rate. See the table on preceding page for industry averages. Take the total pounds of dead animals for the year and divide by 365 days per year. This is the pounds of dead animals that need to be composted each day.

Step Two: Estimate the Volume for the Composting Bins.
Multiply the pounds of dead animals per day from Step One by the cubic feet per pound listed in the adjacent table for the average size of the animals to be composted. This is the required volume for the primary composting area. Add an equal volume for the secondary composting bins.

Multiplier Factor to Estimate Bin Volume by Animal Size

Carcass Size (lb)	*Multiply Death Loss by*
0-10	3 ft^3/lb
10-25	5 ft^3/lb
25-300	10 ft^3/lb
300-750	14 ft^3/lb
750-1400	20 ft^3/lb

Example: You average 100 lb/day of death loss. Average size of dead animal to be composted is about 400 lb. The adjacent table lists the bin volume of 14 ft^3/lb of death loss for animals of that size. (100 lb/ day death loss) x (14 ft^3/lb) = 1400 cubic feet of primary bin space and an equal amount of secondary bin space.

Step Three: Design the Bins.
Start with the bucket width on the loader you will be using. Multiply that width by 2 and round the number up a couple of feet to allow some maneuvering room. For example, if the bucket is 4 ft. wide, you might start your bin design with a width of 10 ft. Depth of the pile should be between five to eight feet. Bins should be at least eight feet long to obtain good pile heating. Try various bin dimensions and number of bins so that the volume available equals the volume calculated above. Bin area (width x length) should fall between 100 and 400 square feet. Include the same number of secondary bins of the same volume and consider adding additional bins for bulking agent storage.

Example: (10 ft. wide to accommodate loader bucket) x (14 ft. long) x (5 ft. deep) = 700 ft^3 per bin. As calculated above, 1400 cubic feet of primary bin space is required to compost daily death loss. 1400 ft^3 divided by 700 ft^3 per bin = 2 primary bins needed. Add two secondary bins of the same size and one bin for bulking agent storage gives a total of 5 bins measuring 10' x 14' x 5'.

Factors in Site Selection of the Composting Structure

Besides the following factors, Minnesota State Board of Animal Health regulations require that Minnesota Pollution Control Agency and local rules also be followed in siting your structure.

Site selection considerations
- ***Water quality***
- ***Biosecurity***
- ***Public view***
- ***Traffic flow***
- ***Water source***

Water quality
Avoid wet areas or flood plains. The facility must be high and dry. Locate at least three feet above high water table and at least 300 feet from streams, ponds, or lakes in the same drainage area. Divert clean water and provide for runoff collection and treatment or storage areas.

Biosecurity
Avoid locating the compost structure directly next to production units and use appropriate cleaning procedures on transportation vehicles.

Public perception
Minnesota State Board of Animal Health regulations require that consideration be given to prevailing winds and public view in choosing a site. Provide limited or appealing view for neighbors or passing motorists and consider aesthetics and landscaping.

Traffic flow
Consider access and traffic patterns required for moving mortalities and bulking agent to the composter and removing finished compost, as well as other farm traffic. Minnesota Board of Animal Health regulations require that carcasses be transported over public roads only in vehicles or containers that are leakproof and covered. Ensure all weather access. Locate safe distances from buried and overhead utilities.

Availability of water
Consider the distance between a water source and the bulking agent storage or the composting bins. If you need to add moisture to your composting materials, either to the bulking agent or to the piles, consider locating the structure within one hose length of a water source.

HOW TO COMPOST STEP BY STEP

Building the Compost Pile

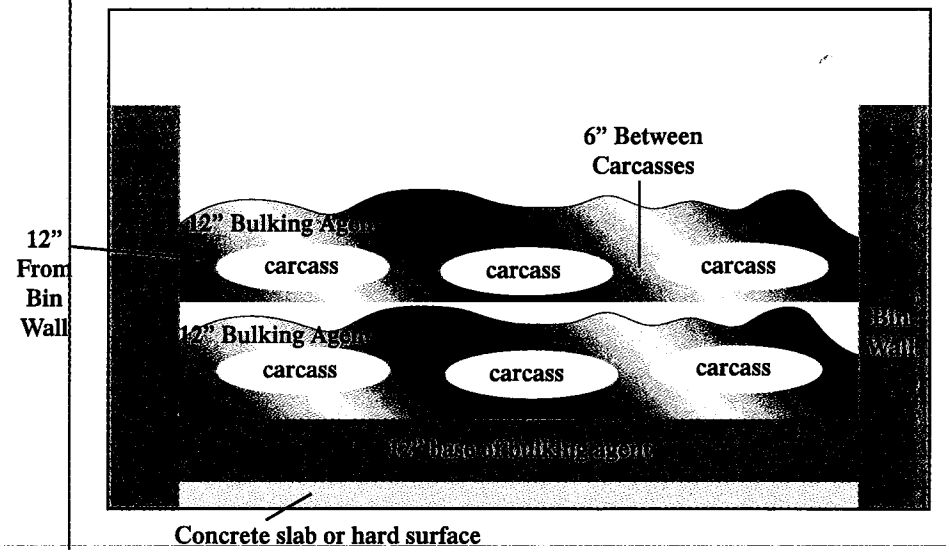
Building the compost pile
- ***Bulking agent base***
- ***Layer carcasses***
- ***Cover with bulking agent***
- ***Record information in log book***

Before you start composting, review the Board of Animal Health Regulations found at the end of this publication.

• Place at least 12 inches of bulking agent on the floor of the composting bin. This layer will insulate the composting material from the outside environment, provide carbon to fuel the composting process, and absorb liquids.

• Place the carcasses in a single layer on top of the bulking agent one foot from the wall of the bin and at least six inches apart. This allows air to circulate around the carcasses and insulates them from the environment. Depending on the size of the bin and of your loader, you may not want to build a whole single layer first, because your loader may not be able to reach the back of the bin when you want to add more carcasses later. You can avoid this by building the pile from the back, building it up and forward simultaneously.

• Cover the carcasses with about 12 inches of bulking agent. Add water as needed to maintain the proper moisture level. Because it is difficult to add water evenly, you might want to consider adding it to the bulking agent before it goes on the pile. Caution: If the pile dries out (25% to 45% moisture) and if piles are too large, spontaneous combustion can occur, just as with hay or silage. Attention to moisture, temperature, and pile size is the best protection. An accessible water supply is a good safety precaution. If you are going to use manure, add it either beneath the bulking agent or incorporated with the bulking agent. The pile is now ready for the next layer.

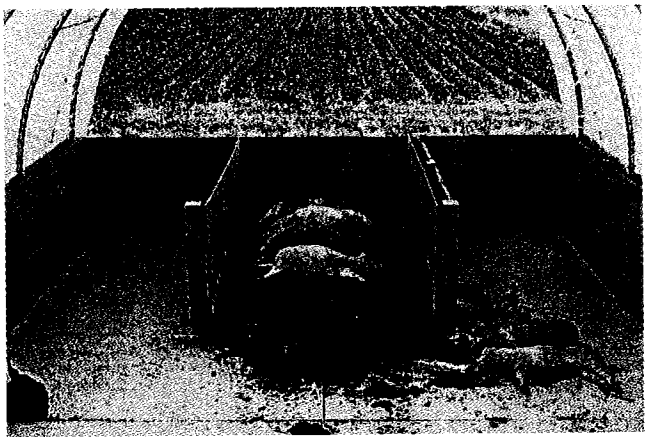


• Record the species, class, and weight of the carcasses, and the amount and type of bulking agent and into the compost log.

• Place additional carcasses as they become available on the pile in layers following these same steps, allowing 6 to 12 inches of bulking agent between layers. Minnesota Board of Animal Health regulations require that animal mortality be processed daily. You can compost more than one species in the same bin. It may be necessary to use the loader bucket to dig a depression to hold the fresh carcass in place before covering it with bulking agent, especially if it is a large animal. Continue adding carcasses until the pile is close to the top of the bin. Cover the top of the pile with 12 inches of bulking agent to reduce odor and protect against pests. Minnesota Board of Animal Health regulations require that flies, rodents, and vermin be controlled so as not to be a health hazard to human or animal populations.

• After the bin is full, start a second bin following these same steps. Leave the first bin to compost. This first bin has carcasses at various stages of decomposition from largely decomposed (first one in) to just beginning (last one in).

Transporting dead sow to composting structure.



One thousand pounds of pigs added in two layers.

Dead sow placed in depression formed in bulking agent.

Covering with bulking agent; note that skid loader fits into bin.

Monitoring the First Heat Cycle

Monitoring
- ***Record temperature daily***
- ***Check odor and moisture***
- ***Troubleshoot and adjust***

• Monitor the pile daily to make sure that all carcass parts stay completely covered by bulking agent. The pile will settle, so you may need to add additional bulking agent over the top.

• Check the temperature daily and record it in the compost log. The temperature should be taken at multiple locations in the pile, especially near the last animal that was added. Temperatures should be increasing and should soon be between 130° and 150° F.

• If it seems that the pile is not composting correctly because of the temperature or because there are odors, you will need to do some troubleshooting and make adjustments. See the section on troubleshooting for more information.

• Once the pile reaches at least 130°F, it should stay above that temperature for at least one week. Do not start counting the days until the area that you added to the pile last reaches this temperature. When the temperature drops, the pile is ready to be turned.

• The typical primary composting time is approximately 45 days for carcasses weighing from 25 to 300 lbs. See the table of estimates for primary composting times by carcass weight.

Primary Composting Times

Primary Carcass Size (lb)	*Estimated Composting Days*
0-10	15
10-25	22
25-300	45
300-750	60

Turning the Pile

• Layer the bottom of an empty bin with 12 inches of bulking agent.

• Use a front-end or skid loader to move the material from the primary bin to the secondary bin, one bucket at a time. This aerates the pile. Minimal flesh or soft bones should be present, but long bones, skulls, teeth, and pelvis, and some hide, feathers, and fleece may remain. There may be some odor while turning due to disturbance of the anaerobic zones. Look to see whether you need to add water. If you do, add it to the existing pile as needed before or while you turn it, so that it gets evenly incorporated.

Caution: High temperatures created by the composting material could lead to burns of the skin if caution is not exercised during compost handling.

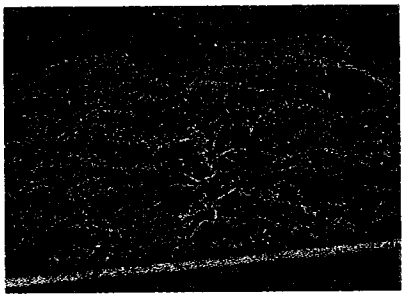
• Cover the fresh pile with another 12 inches of bulking agent to prevent odor and visits by scavenging animals.

• Record the date turned and bulking agent type and volume used in the compost log.

Compost Bin Management

Example for a 3-bin, 2-turn system with 15 days in primary heat cycle.

Days	*Primary Bin 1*	*Primary Bin 2*	*Secondary Bin*
1-15	filling	empty	empty
16-30	1st heat	filling	empty
31-45	filling	1st heat	2nd heat (#1)
46-60	1st heat	filling	2nd heat (#2)
61-85	filling	1st heat	2nd heat (#1)



Appearance of carcasses after first heat cycle.

Monitoring the Second Heat Cycle

• Monitor and record the temperature of the turned pile daily. Since the composting materials are more consistent now, you don't need to be as careful about taking the temperature in multiple locations.

• Once the pile maintains a temperature in excess of 130° F for seven days and then drops, the compost may be finished.

• Secondary composting times will be similar to the number of days in the primary cycle.

Finishing the Composting

Inspect the pile. If you can no longer see any flesh, the compost can be termed "finished." It should be dark, humus-like material with very little odor. At this stage, any bones should be so brittle that they can be easily crushed. Minnesota Board of Animal Health regulations require that the finished product contain no visible pieces of soft tissue. If there is still some flesh visible, you need to turn the pile again and let it go through another heat cycle. With larger animals such as cattle and sheep, more time is needed to completely compost their larger and denser bones. If the compost is finished other than the bones, remove them and place in a new pile for further decomposition.

Notes on Winter Composting

In order to compost in the winter, the compost pile must never be allowed to go cold. New carcasses should not be allowed to freeze and should not be added to a pile that has dropped below 60° F, which is too cool for microbial activity to start. The compost pile must be large enough to provide self-insulation. A thick layer of bulking agent between the carcasses and the floor and walls of the bins will insulate the microbial activity from cold air. Turning on extremely cold days should be avoided. You can also do your composting in or next to a heated area in the winter.

Notes on Catastrophic Herd/Flock Loss

Composting assistance is available if you suffer catastrophic animal mortalities. Your capacity to effectively and safely compost your carcasses may be rapidly exceeded with large losses. In the event of a large scale loss due to disease, it is critical that you contact the Minnesota Board of Animal Health for disease and emergency composting guidance. In order to minimize spread of disease, poultry affected with diseases, such as avian influenza can be composted inside poultry barns.

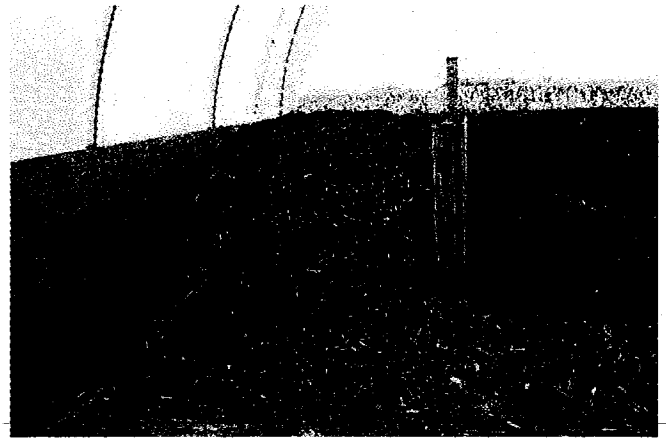
Emergency Contacts:

MN State Duty Officer
651-649-5451

Board of Animal Health
651-296-2942

Information needed for composting assistance includes:

- *Current on-site composting capacity*
- *Potential on-site composting capacity*
- *Availability of Composting supplies (e.g., wood chips, sawdust or other materials)*



Finished compost.

MONITORING AND TROUBLESHOOTING

Troubleshooting Guide for Carcass Composting
Adapted from the National Pork Producers Council Swine Mortality Composting Module

Problem/ Symptom	Probable Cause	Suggestions
Improper Temperature	• Too dry • Too wet • Improper C:N ratio or bulking agent used is too porus • Adverse environment	• Add water • Add bulking agent and turn pile. • Evaluate bulking agent and adjust amount as necessary. • Ensure adequate cover with bulking agent to provide insulation.
Failure to Decompose	• Improper C:N ratio • Carcasses layered too thickly • Carcasses placed on the outside edge of the pile	• Turn pile and adjust amoun of bulking agent. • Single layer the carcasses • Maintain one foot of space between carcasses and outside edge of bins..
Odor	• Too wet • Too low C:N ratio • Air flow restricted • Inadequate cover over carcasses • Extended periods of low temperature	• Add bulking agent and turn pile. • Evaluate type of bulking agent used. Add bulking agent. • Maintain one foot of bulking agentnear outside of bin. Turn pile. • Cover carcasses with one foot of bulking agent. • Follow steps in temperature section.
Flies	• Inadequate cover over carcasses • Poor sanitation conditions • Failure to achieve proper temperature • Too wet	• Cover carcasses with one foot bulking agent. • Avoid leaching from pile. Maintain a clean, debris free area near the pile. • Follow steps in temperature section. • Open/remove pile contents and add additional bulking agent
Scavenging Animals	• Inadequate cover over carcasses	• Maintain one foot of cover. carcasses • Avoid initial entry by establishing a fence or barrier.

USE OF COMPOST ON THE FARM

Once the compost is finished, it may be used for some of the bulking agent in a new composting pile. A rule of thumb is 50 percent, but you may want to use more or less depending on how degraded the bulking agent is in the finished compost. Using finished compost in new compost piles reduces the amount of bulking agent you need in the new pile and provides microbial inoculant.

Compost may also be applied to your fields. This should be considered part of your current manure management plan.

Since there are no state rules or regulations that specifically address land application of mortality compost, you should use the application requirements for manure as guidelines. Compost nutrient estimates are 15 lb of N, 5 lb of P_2O_5 and 10 lb of K_2O per ton of compost. Nutrients would be higher if manure or turkey litter were used in the compost. In order to determine the proper application rates for your compost, you will need to determine its nutrient content and availability. Most soil and manure testing labs will do this.

REGULATIONS

Minnesota Board of Animal Health Rules

Composting structure

- built on an impervious weight-bearing pad that is large enough to allow the equipment to maneuver. An 8-foot apron to support the front wheels of the loader is the minimum recommended though concrete to support the entire loader is recommended.
- covered with a roof or other water-repelling materials to prevent excessive moisture on the composting material. The roof overhang should minimize rain blowing into the bins.
- built of rot resistant material that is strong enough to withstand the force exerted by the equipment. Possible construction materials for the bins include preservative pressuretreated lumber and concrete. To avoid corrosion, ventilation is needed and hot-dipped galvanized nails should be used.
- large enough to handle each day's normal mortality through a minimum of two heat cycles to the endpoint of composting.
- sited with consideration to prevailing winds and public view.

Compost Pile

- C:N ratio between 15:1 and 35:1.
- 12" base of bulking material.
- carcasses six inches from edges.
- reach a minimum of 130° F.
- carcasses covered and sealed with litter as they are added to pile.
- flies, rodents, and vermin controlled so as not to be a health hazard to human or animal populations.
- temperature taken and recorded daily.
- minimum of two heat cycles.

Livestock

- permit required for composting cattle.
- no composting of any animals that died from anthrax or toxic materials.

- animal mortality processed daily.
- carcasses transported over public roads only in vehicles or containers that are leak proof and covered.

Finished Compost
- minimum of two heat cycles have reached 130oF.
- finished product must not contain visible pieces of soft tissue.
- finished product must be handled and stored according to Minnesota Pollution Control Agency and Department of Agriculture regulations.

Protocol
The owner of the compost facility should have a written protocol for the operation containing at least the minimum steps outlined above in the composting process and should instruct and be responsible for all employees to follow the protocol.

Inspection
Representatives of the Board may inspect a composting facility and may review the operation protocol at any reasonable time.

Penalties
Construction or operation of a compost facility in violation of the rules results in penalties pertaining to improper disposal of dead animals as well as possible charges for violations of the rules of other state or local agencies.

Local Rules and Regulations

In addition to state regulations, most counties will require a building permit to construct or modify an existing building for composting. Before construction, contact your local zoning office to obtain the necessary permits. Local governments may have ordinances that are stricter than state regulations, or they may not have ordinances that cover animal mortality composting. In this case, local feedlot rules governing animal waste are generally used as guidelines for building the composting structure. Special or conditional use permits may be needed on a local level for composting. County feedlot ordinances may have carcass disposal requirements as part of the feedlot permit.

Emergency Number for Catastrophic Animal Loss:

Minnesota State Duty Officer

651-649-5451

MINNESOTA STATE AGENCIES AND OTHER KEY ORGANIZATIONS

Animal Mortality Composting Demonstration Sites.
For farmer demonstration sites, contact the Minnesota Department of Agriculture, Agricultural Development Division, 90 W. Plato Blvd., St. Paul, MN 55107. (651)296-7673.

Board of Animal Health (BAH).
625 Robert Street North, St. Paul, MN 55155-2538.
(651)296-2942. BAH Communications Staff: (651)201-6827
www.bah.state.mn.us/

Department of Biosystems and Agricultural Engineering.
University of Minnesota Extension Service. Room 213 Agricultural Engineering Building, 1390 Eckles Avenue., St. Paul, MN 55108.
(612)625-7733 Fax: (612)624-3005.
www.bae.umn.edu/

Minnesota Department of Agriculture (MDA)
625 Robert Street North, St. Paul, MN 55155-2538. (651)201-6000.

General Composting Questions:
Matt Drewitz, Senior Planner, Agricultural Resources Management and Development Division: (651)201-3820

Emergency Response and Catastrophic Losses:
Heidi Kassenborg, Emergency Response Director, Food and Dairy Division: (651)201-6625
Michele Puchalski, Hydrogeologist, Incident Response Unit, Pesticide and Fertilizer Division: (218)444-3403
www.mda.state.mn.us

Minnesota Pollution Control Agency (MPCA)
To find the regional office closest to you, contact the MPCA at 520 Lafayette Road, St. Paul, MN 55155-4194. (651)296-6300.
MPCA website: www.pca.state.mn.us
MPCA Feedlot website: www.pca.state.mn.us/hot/feedlots.html

University of Minnesota
David Schmidt, P.E.
Department of Biosystems and Agricultural Engineering Dept.
1390 Eckles Avenue, St. Paul, MN 55108-6005, 612-625-4262
www.bae.umn.edu/

University of Minnesota Extension and Outreach Centers
U of M Southern Research and Outreach Center.
A composting demonstration site using swine, cattle, and sheep. 35838-120th Street, Waseca, MN 56093-4521.
(507)835-3620. Fax: (507)835-3622.
http://sroc.coafes.umn.edu/

U of M Southwest Research and Outreach Center
23669 130th Street, Lamberton, MN 56152
(507)752-7372 Fax: (507)752-5097
http://swroc.coafes.umn.edu/

U of M West Central Research and Outreach Center.
A composting demonstration site using swine and cattle.
46352 State Highway 329, Morris, MN 56267-0471.
(320)589-1711. Fax: (320)589-4870.
http://wcroc.coafes.umn.edu/home.html

U of M North Central Research and Outreach Center.
A composting demonstration site using swine and cattle.
1861 Highway 169 East, Grand Rapids, MN 55744.
(218)327-4490. Fax: (218)327-4126.
http://ncroc.coafes.umn.edu/

U of M Northwest Research and Outreach Center
2900 University Ave., Crookston, MN 56716
(218)281-8604 Fax: (218)281-8603
http://nwroc.umn.edu/index.htm

United States Department of Agriculture-Natural Resources Conservation Service (USDA NRCS)
375 Jackson Street, Suite 600, St. Paul, Minnesota 55101
(651) 602-7900
National USDA NRCS website: www.nrcs.usda.gov/
Minnesota USDA NRCS website: www.mn.nrcs.usda.gov/

FURTHER RESOURCES

Publications and Web Sites

Animal Disposal Web Page.
Minnesota Department of Agriculture.
www.mda.state.mn.us/composting/default.htm

Composting Animal Mortality Resource Notebook.
Lynn Carpenter-Boggs, editor. 1999. Miscellaneous publication number 100-1999. Minnesota Agricultural Experiment Station. St. Paul, MN. Available from the West Central Research and Outreach Center, 46352 State Highway 329, Morris, MN 56267. (320)589-1711. Fax: (320)589-4870.
http://wcroc.coafes.umn.edu/

Carcass Disposal Web Page.
Minnesota Board of Animal Health
www.bah.state.mn.us/animals/carcass_disposal/carcass_disposal.htm

Dis-Solving Swine Mortality Problems.
2001. Iowa State University. Available from ISU, Department of Agricultural and Biosystems Engineering, Ames, IA 50011.
www.abe.iastate.edu/PigsGone/index.htm

Guidelines: Land Application of Manure for Water Quality Protection.
1996. Minnesota Pollution Control Agency (MPCA). Available from MPCA-Nonpoint Source Compliance Section, 520 Lafayette Road N, St. Paul, MN 55155-4194. (651)296-6300.

Minnesota Livestock Producer's Feedlot Planning and Operations Manual.
2002.: Agricultural Resources Management and Development Division, Minnesota Department of Agriculture, 625 Robert Street North, St. Paul, MN 55155-2538, (651) 201-6520
www.mda.state.mn.us/feedlots/feedlotguide.htm .

Minnesota Board of Animal Health Rules.
Available from the Minnesota Board of Animal Health, 625 Robert Street North, St. Paul, MN 55155-2538. (651)296-2942. Fax: (651)296-7417. www.revisor.leg.state.mn.us/arule/1719/4000.html

On-Farm Composting Handbook.
Robert Rynk, editor. 1992. NRAES-54. Available from the Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701. (607)255-7654. Fax: (607)254-8770. E-mail: NRAES@cornell.edu.
www.nraes.org/publications/nraes54.html

Swine Composting Facility Design.
1997. Ohio State University. Factsheet AEX-713-97. Available from OSU Department of Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210.
http://ohioline.osu.edu/aex-fact/0713.html

Swine Mortality Composting Module.
Kellie McGuire, editor. NPPC National Office
10664 Justin Drive Urbandale, IA 50322. (515) 278-8012 .
Fax: (515) 278-8011.
www.nppc.org/

Thermometer Suppliers

Suggested: a bimetal composting thermometer with a 20-36 inch, heavy duty 3/8 inch diameter stem, with a back connected, three inch dial with a temperature scale of 0 to 200° F. Cost: $11 to $90.

Nasco Farm & Ranch.
901 Janesville Ave., P. O. Box 901, Fort Atkinson, WI 53538.
(800)558-9595. *Product number C14312N, baled hay and compost thermometer, 20 inch stem for about $11.50.
www.enasco.com/

Reotemp Instruments Corp.
10656 Roselle St., San Diego, CA 92121.
(858)784-0710.
www.reotemp.com

Tel-Tru Manufacturing Co.
408 St. Paul Street, Rochester, NY 14605. (800)232-5335.
www.teltru.com

Trend Instruments, Inc.
1000 Wiegand Blvd., Lawrenceville, GA 30043. (888)WIKA-USA.
www.wika.com

Weksler Instruments.
(800)328-8258.
www.weksler.com/

BIBLIOGRAPHY

Carpenter-Boggs, Lynn, editor. 1999. Composting Animal Mortality Resource Notebook. Miscellaneous Publication Number 100-1999. Minnesota Agricultural Experiment Station. St. Paul, MN.

Carter, Thomas A., et al. 1996. Composting Poultry Mortality. Publication Number PS&T-47. North Carolina Cooperative Extension Service. Raleigh, NC.

Collins, Eldridge R., Jr. 1996. Composting Dead Poultry. Publication Number 442-037. Virginia Cooperative Extension. Blacksburg, VA.

Fulhage, Charles. 1996 (Reprint). Composting Dead Swine. Publication WQ351.University of Missouri Extension Service. Columbia, MO.

Glanville, Thomas D. 2001. Dis-Solving Swine Mortality Problems. Iowa State University, Ames, IA. ae.iastate.edu/pigsgone/

Glanville, Thomas D., and Darrell W. Trampel. 1997. Composting Alternative for Animal Carcass Disposal. Journal of the American Veterinary Medical Association. Vol. 210, pages 1116-1120.

Langston, John, Karl VanDevender, and Jack C. Boles, Jr. Undated. Disposal of Poultry Carcasses in Arkansas. Cooperative Extension Service, University of Arkansas. Little Rock, AR.

McGuire, Kellie, editor. Undated. Swine Mortality Composting Module. National Pork Producers Council. Clive, IA.

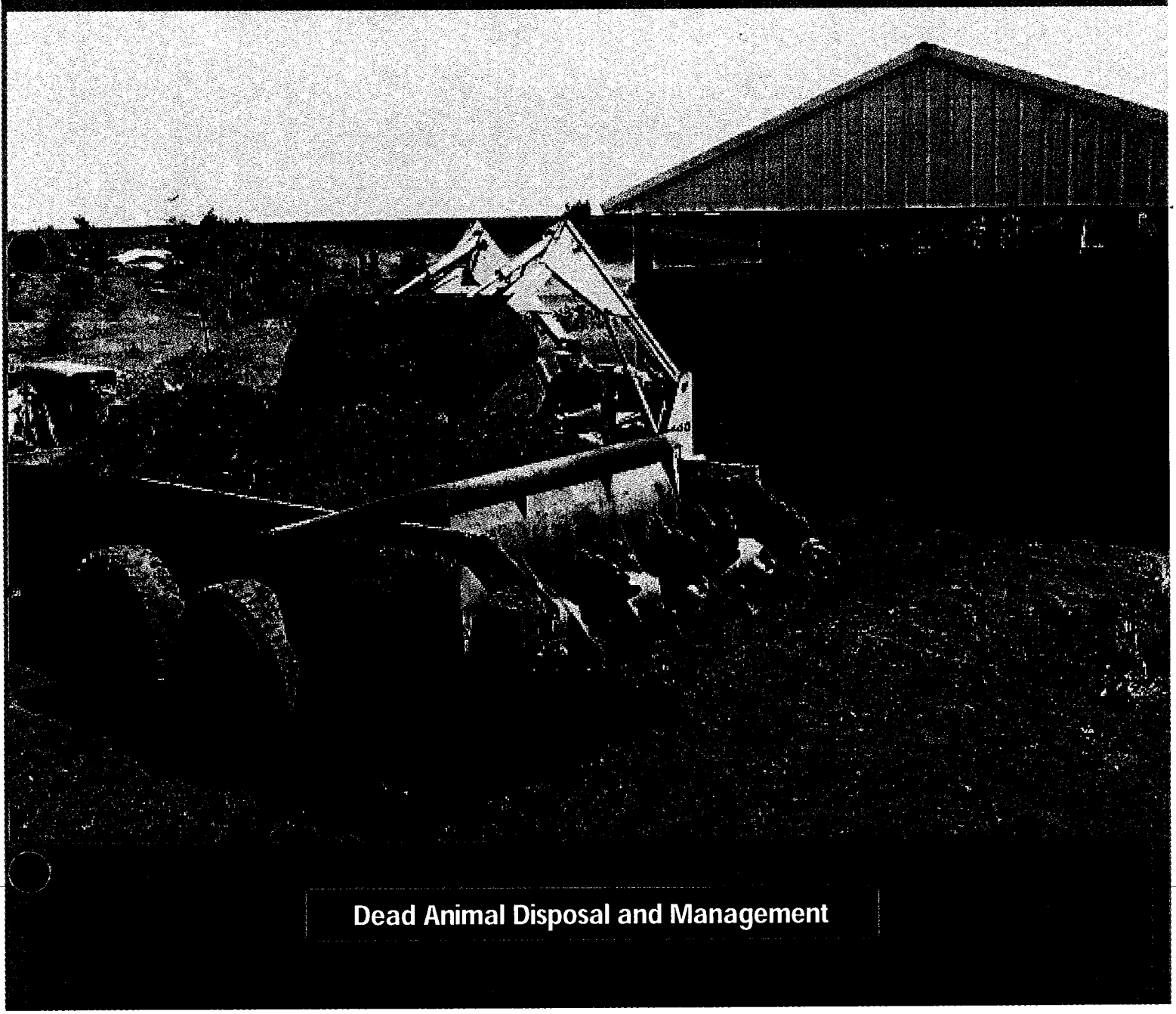
Mescher, Terry, et al. 1997. Swine Composting Facility Design. Publication AEX-713-97. Ohio State University Extension. Columbus, OH.

Minnesota Board of Animal Health Rules. Chapter 1719.0100 - 1719.4600.

Walker, Roger, and Bill Crawford. 1997. Composting Swine Mortality in Minnesota. Presented at 1997 University of Minnesota Pork Conference. University of Minnesota. St. Paul, MN.

Iowa Farm*A*Syst

Assessing Your Dead Animal Management Practices



Dead Animal Disposal and Management

What is Farm•A•Syst?

Farm*A*Syst (FAS) is a national program which originated at the University of Wisconsin. Forty-six states and U.S. territories have taken the basic FAS material, modified it to fit their locale and are currently distributing it. In Iowa, Farm Bureau has taken the lead in adapting the national model to meet the needs of Iowans.

The goal of FAS in Iowa is to reduce the risk of water pollution, particularly drinking water pollution. Iowa Farm*A*Syst is designed to educate farmers and acreage owners on safeguarding their water supply. Farm*A*Syst also alerts rural residents if their current practices are endangering the safety of their water supply or are against Iowa law.

How is this accomplished?

The material is simple and easy to understand. The evaluation can be completed by the acreage owner in private, or with the help of local technical specialists. If the acreage owner has questions or needs additional assistance, the FAS material directs them to professionals. Farm*A*Syst may be a first step for farmers and acreage owners before costly and comprehensive environmental audits are needed. Farm*A*Syst encourages voluntary environmental protection.

The chapters are designed to give the reader some background on the subject matter so they can complete a short assessment of their current practices. The materials are written so that farmers and acreage owners who value confidentiality can use the materials without having to seek outside advice.

What topics are covered?

This topic is just one of the many topics covered by Farm*A*Syst. Iowa Farm*A*Syst publications include:

- Pesticide Storage & Management
- Fertilizer Storage & Management
- Site Assessment
- Milking Center Wastewater Practices
- Open Feedlot Manure Management Practices
- Confinement Livestock Manure Storage Practices
- Dead Animal Disposal and Management
- Water Well Condition and Maintenance
- Household Wastewater Management
- Hazardous Materials Storage & Management
- Petroleum Storage & Management

Iowa Farm•A•Syst
312 W. 3rd Street • Carroll, IA 51401 • 712/792-6248

Dead Animal Disposal

There's an old adage that says, "The only things in life that are certain are birth, death and taxes." Farmers are quite accustomed to dealing with all three. However, most people do not think about the possibility of contaminating their drinking water with mishandled dead animals. Your drinking water may be endangered by disease-causing bacteria and excess nutrients from dead animals improperly disposed of on your farm. This section focuses on how to manage on-farm livestock deaths while maintaining the quality of your drinking water.

In the past, the most popular method for disposing of dead livestock was through a rendering service. However, in recent years the number of rendering plants has greatly decreased. The cost of rendering service has also increased which has led producers to explore new methods of dealing with dead animal disposal. Burial, rendering, composting and incineration are covered in this chapter.

NOTE: This chapter does not summarize all the laws related to livestock operations in Iowa. Due to the complexity of Iowa Code, the Iowa Department of Natural Resources (DNR) rules and the Iowa Department of Agriculture and Land Stewardship (IDALS) rules, you are advised to contact your regional DNR office or IDALS office if you have questions that are not addressed in this chapter. Contact information for the DNR and IDALS offices is located in the "For More Information" section in the back of this publication.

According to Iowa Code, all dead animals must be disposed of within 24-hours of death.

"Can I use a rendering service to dispose of dead livestock on my farm?"

Rendering

Rendering is a practice that converts dead animals to a value-added product, such as protein feed. If rendering services are readily available or a farm is producing few dead animals, it may be convenient to dispose of animals by using a rendering service. On the downside, the rendering truck can be a source of disease as it travels from farm to farm, and weekend pick ups are not offered. Because the cost of rendering has risen some farms are exploring the use of alternative disposal methods.

Dead animals to be picked up by a rendering service should be placed in a secure structure to prevent access by pets, wild animals and rodents.

"Are there laws that impact how I bury dead animals on my farm?"

If you need to dispose of a catastrophic loss, contact the state veterinarian and your DNR field office for assistance.

Burial

Burial is a very common practice and is often the disposal method of choice for catastrophic livestock losses. However, frequent burial of dead animals can be time consuming and nearly impossible in the winter.

Excessive nitrogen and pathogenic (disease-causing) organisms from improperly buried dead animals can pollute ground and surface water and may contaminate your drinking water.

DNR rules outline the requirements for legal burial of dead animals. To ensure the quality of your water is not harmed by bacteria from improper livestock burial, follow these rules as defined by Iowa Code:

- The dead animals must result from the operation located on the premises where burial occurs.
- Dead animals must be buried within 24 hours of death.
- Dead animals must be buried in soils that are classified as moderately well drained, well drained, somewhat excessively drained or excessively drained. Other soils can be used if artificial drainage is used to maintain a water level depth more than two feet below the burial depth.
- The burial pit must be no deeper than six feet.
- The dead animals must be immediately covered with a minimum of six inches of soil and finally covered with at least 30 inches of soil.
- Dead animals cannot be buried in flood plains, wetlands or on a shoreline. The following separation distances must be maintained between burial sites and water sources:

Separation Distance for Burial Sites	Separation Distance
Private water wells	100 feet
Public water wells	200 feet
Surface water body, such as streams, lakes, ponds or intermittent streams	100 feet

According to the Iowa Code, the maximum number of dead animals that can be buried on one acre in one year are:

- 7 cattle, slaughter or feeder OR
- 44 swine, butcher or breeding OR
- 73 sheep or lambs OR
- 400 poultry.
- All other species are limited to two dead animals per acre.
- Animals that die within two months of birth may be buried with no regard to number.

The animals should be buried at a number of sites, not all at one site.

"I've heard a lot about composting. Is it a viable alternative for my farm?"

Composting

Composting is similar to following a recipe:

- **Moisture** content is crucial, as it needs to be between 40 and 60 percent.
- **Co-composting materials** surround the dead animal, provide carbon and protect the dead animals from rodents, insects and scavengers.
- **Carbon and nitrogen** are key ingredients, required in an optimum 25:1 ratio for favorable microbial activity.
- **Oxygen** is required by the microbes. Without oxygen, unpleasant odors may form and the process will take longer.
- **Heat** is a by-product of microbial activity, and is needed to sustain the degradation process.

Composting creates a humus-like product containing nutrients and organic matter which is beneficial to cropland. Composting of dead animals first caught on in the mid 1980s for disposal of daily mortalities at poultry farms in the South. The Midwest has been slow to adopt composting practices because it was thought that the cold winter climate would hinder the process. However, research has shown that composting in Iowa can work just as well as it does in the South.

Composting isn't just for poultry, as it is being rapidly adopted by swine farms in Iowa.

For more information on composting and other methods of dead animal disposal, contact the Waste Management Assistance Division of the DNR. Contact information is in the "For More Information" section at the end of this publication.

To ensure the quality of your water is not harmed by bacteria or excess nutrients from improper composting, follow these rules, as defined by the DNR:

- Dead animals must be placed in the composting process within 24 hours of death.
- Dead animals in the compost must be sufficiently covered to prevent access by domestic and wild animals. The dead animals should be covered with animal manure, livestock bedding, crop residue, clean wood waste or other suitable compost materials.
- Composting must be done in a manner which prevents the formation and release of runoff and leachate and controls odors, insects and other vermin.
- Composting must be conducted on an all-weather surface of compacted soil, compacted granular aggregates, asphalt, concrete or similar impermeable material. The surface must permit access during inclement weather.
- A roof over the facility is not mandatory, but recommended. However, the DNR may consider requiring a roof in certain specific instances.
- Dead animals are not to be removed from the composting process until all flesh, internal organs and soft tissue have been fully decomposed.
- The finished compost material cannot be stored longer than 18 months.
- The compost must be applied to cropland. The application rate should not exceed the rate at which sufficient nitrogen is provided to obtain optimum crop yields. The compost must be applied in such a manner to prevent runoff. Application to land other than cropland requires prior approval by the DNR.

- If large animals are composted, it may be necessary to grind large bones before land application.
- Compost facilities cannot be located in a 100-year flood plain. The following composting facility separation distances must be maintained:

Separation Distance for Composting Sites	Separation Distance
Private water wells	100 feet
Public water wells	200 feet
Flowing or intermittent streams, lakes or ponds	100 feet

"Can I incinerate dead animals on my farm?"

On-Farm Incineration

Incineration provides little concern for water quality and disease transmission because the dead animals are reduced to ashes at very high tempretures. However, there may be some concern for air quality if the incinerators are not sized or managed properly. Incinerators are costly to purchase and operate and require a certain level of maintenance and management.

The constuction and operation of an incinerator capable of cremating more than 25 pounds per hour requires a permit from the DNR Air Quality Bureau.

For More Information

Iowa Department of Natural Resources, Waste Management Assistance and Land Quality Bureaus

Composting information
(515) 281-8308

Permiting information
(515)281-8912

Wallace State Office Building, Des Moines, IA 50319-0034
http://www.state.ia.us/dnr/organize/cpd/solwaste/solwaste.htm

DNR Environmental Protection Division Field Offices

Atlantic	(712) 243-1934
Des Moines	(515) 281-9069
Washington	(319) 653-2135
Manchester	(319) 927-2640
Mason City	(641) 424-4073
Spencer	(712) 262-4177

- Provides assistance with state regulations of compost facilities.
- Assists with burial location for catastrophic losses.

Iowa Department of Natural Resources, Air Quality Bureau
(515) 281-5100

79 Hickman Road
Urbandale, IA 50322
www.state.ia.us/dnr/organiza/epd/airq/aqbur.htm

- Assist with incineration regulations & permitting.
- Provides permit applications on-line and in paper copy.

Iowa Department of Agriculture and Land Stewardship, Animal Industry Bureau/State Veterinarian
(515) 281-8615

Wallace Building
Des Moines, IA 50319

- Assists with catastrophic burial.
- Assists with Iowa Code burial requirements.

National Pork Producers Council

(515) 223-2600

1775 N.W. 114th Street
Clive, IA 50306
www.nppc.org

- Promotes the environmental assurance program Composting Module.

Natural Resources Conservation Service

Contact the local NRCS/SWCD (Soil and Water Conservation District) office located in your county.

- Information available on NRCS standards for composting facilities.

Iowa State University Extension

Contact your county extension office. The county director, or area ag engineer may be able to answer your questions or direct you to other Extension specialists

- Publications on a variety of topics are available at Iowa State University county extension offices, or from the Publication Distribution Center, Ames, (515) 294-5247. Many of the publications are available online at *www.extension.iastate.edu/Pages/pubs*
- Publication SA-8 - Composting Dead Livestock: A New Solution to an Old Problem *www.ag.iastate.edu/centers/leopold/SA8.pdf*
- Midwest Plan Services has publications on facility design. *www.mwpshq.org* (515) 294-4337

Good features of my farmstead:

Potential problems that could cause groundwater contamination:

What I plan to do to remedy potential problems:

Evaluate your potential risk for having unsafe drinking water. The evaluation areas are in the shaded 'Risk' column. Choose the answer that best fits your situation, as listed in the boxes to the right. Note how likely you are to have drinking water problems, as indicated by "low risk," "moderate risk" and "high risk."

- Take special note of the critical evaluation points. If you fail to meet these standards, your drinking water supply is in immediate danger.

- Those situations that violate Iowa Code are indicated by '**!**' and printed in bold text.

Risk	Low Risk	Moderate Risk	High Risk
Rendering service			
Dead animal management	• Request for pick up is made within 24 hours of death AND • Dead animals are stored in secured structure until pick up.		**• Dead animals not disposed of within 24 hours of death OR** **• Dead animals left in open OR** **• Dead animals stored near wells or surface water.**
Burial			
Burial site	• Dead animals buried outside of flood plains and wetlands AND • Dead animals are not buried within 100 feet of a private water well AND • Dead animals are not buried within 100 feet of surface water.		**• Dead animals buried in flood plains or wetlands OR** **• Dead animals buried within 100 feet of a private water well or surface water.**
Burial process	• Dead animals immediately covered with six inches of soil AND • Dead animals eventually covered with 30 inches of soil AND • Burial pit less than six feet deep AND • Groundwater table does not enter the burial pit.		**• Dead animals not immediately covered with six inches of soil OR** **• Permanent coverage of dead animals with soil is not at least 30 inches deep OR** **• Burial pit more than six feet deep OR** **• Water from groundwater table enters burial pit.**
Composting practices			
Composting site	• Composting site located outside of 100-year flood plain AND • Site is 100 feet from private water wells and surface water.		**• Site located in a 100-year flood plain OR** **• Site is less than 100 feet from private water wells OR** **• Site is less than 100 feet from surface water.**

Risk	Low Risk	Moderate Risk	High Risk
Composting process	• Dead animals are completely covered with organic material AND • Composting done in a manner that prevents runoff of leachate.		• **Dead animals are not sufficiently covered with organic material AND** • **Composting not conducted in a manner that prevents runoff of leachate.**
Incineration practices			
Incineration practices	• All dead animals are incinerated in DNR approved incinerator within 24 hours of death.		• **Dead animals not incinerated within 24 hours of death OR** • **Dead animals disposed of in unapproved incinerator, or without use of incinerator, such as open burning.**

Critical

Violates Iowa Code

Publication of this document has been funded in part by the Iowa Storm Water Education Program and by the Iowa Department of Natural Resources through a grant from the U.S. Environmental Protection Agency under the Federal Nonpoint Source Management Program (Section 319 of the Clean Water Act).